MECHANIZATION IN COAL MINING

By F. E. STEELE, '29

Mechanical loading of coal has made such rapid advances in the past five years that it has obtained for itself a place of primary importance among manufacturers of coal mining equipment and coal operators. Based upon statistics published by the United States Government, it is estimated that in excess of 18,000,000 tons of bituminous coal were mechanically loaded during the year 1928. This tendency toward mechanization has produced a great variety of ingenious machines, all of which can be roughly divided into three distinct classes of equipment, namely, mechanical loaders, conveyors, and scrapers.

MECHANICAL LOADERS

Mechanical loaders are those machines designed to lift the coal from the mine floor, carry it back and discharge it into a mine car, or other means of conveyance. These machines must be able to travel from working place to working place under their own power and are either track mounted or mounted on caterpillar treads. The latter type have the advantage of being able to maneuver into any position in front of the coal face. "This mobility makes them very adaptable for direct substitution of hand loading in the room and pillar system and the majority of loading machines now installed are used in entry and room work."*

Practically no cleaning of the coal at the face can be done when mechanical loaders are used. Some cleaning can be effected when the impurities occur in a definite band by cutting in the band and discarding these impurities inside the mine, but in a seam of coal containing numerous bands of impurities this is impractical and some means of cleaning is usually employed on the surface. Mechanical loaders can be used in practically every seam of coal over five feet in height.

SCRAPERS

Scrapers consist of bottomless scoops which are dragged along a working face by a rope hoist, collecting, transporting, and finally discharging coal into a mine car. Scrapers lack the mobility of mechanical loaders but can be used for working several places during a single shift by one of two methods. In one case the hoist is mounted on a truck that is propelled from one working place to another and in the other the hoist is set in one location with a system of ropes and sheaves which operate the scrapers in as many as seven different rooms. Scrapers are especially adapted to low coal and are used in coal seams from 24 inches in thickness, upward.

CONVEYORS

Conveyors are of four types, namely, pit car loaders, shaking conveyors, drag chain, and rubber belt conveyors.

Pit car loaders are portable track mounted conveyors onto which coal is shoveled and elevated to a mine car. This type of conveyor is rapidly growing in popularity due to its low first cost and the increased output per man.

In the use of shaking conveyors the coal is either hand shoveled onto the conveyor or mechanically shoveled onto the conveyor by means of a shaker loader, consisting of a broad scoop-like attachment, called a "duckbill," located on the front end of the conveyor. The shaker loader picks the coal up from the mine floor by the shaking motion imparted by the conveyor as it feeds into the pile of loose coal. A peculiar reciprocating motion causes the coal to flow along the conveyor.

The drag chain conveyor, more commonly known as the sectional conveyor, consists of sections of steel trough, usually six feet in length, through which is dragged a chain or chains carrying flights, about two feet apart. Both the shaker and chain type of conveyor remain in one working place and are portable only in the sense that they can be shifted from place to place and extended in sections, up to a maximum of about 300 feet.

Rubber belt conveyors consist of endless belts running on two large pulleys or drums with intermediate supporting rollers. This type of conveyor is not yet very generally used for transporting coal underground.

Some coal cleaning can be accomplished underground when conveyors are used but the tendency in most recent conveyor installations is toward not delaying the operation by hand picking but to depend upon tipple preparation to insure a clean marketable product. Conveyors are especially adapted to low coal but can be and are used in seams of coal ranging from 24 inches up to exceedingly thick seams.

Mechanical loading has been growing so rapidly during the past five years that as yet little can be done toward standardization. No set rule can be accepted by the mining industry such as, mechanical loaders shall be confined to high coal and scrapers and conveyors used only in low coal. There are at present two distinct lines of thought and endeavor; one which believes that mechanical loading will be developed to apply to all seams of coal—using conveyors if they are to be used at all, solely as an auxiliary to the loaders;—and the other, which believes that conveyor mining—either with hand-shoveling or with types of face conveyors designed to eliminate hand-shoveling, will be developed with mining systems for all heights of coal and seam conditions.

Mechanical loading in all of its forms gives little chance for cleaning the coal at the face compared to the old system of hand loading where practically all cleaning required was accomplished by the individual miner underground. This, along with the demand of the consumer for a cleaner coal, has resulted in the building of several large coal cleaning plants throughout the country.

* Southard, G. B.—Mining Congress Journal. Vol. 14, No. 6, p. 412.

Coal Cleaning

Coal cleaning is a term applied to the removal of the foreign impurities of coal. Impurities occur in coal in either of two forms, inherent impurities which are not removable by cleaning and foreign impurities which can be removed or materially reduced by some one or more of the different methods of coal cleaning.

The problem of cleaning coals is a complicated one. In the first place the operator must determine whether or not his coal can be profitably cleaned, that is, he must study the market and find out whether the increased price he can obtain for clean coal will more than offset the cost of installation and operation of coal cleaning equipment. Then if conditions seem favorable, his biggest problem is the selection of the type of equipment that is most adaptable to his particular seam of coal. His selection should be based upon the following requirements:

1. It should have adequate capacity and be able to prepare coal of a wide range of sizes.
2. It should give a product containing a minimum amount of impurities and a refuse containing a minimum amount of coal.
3. It should have a low cost of maintenance and operation.
4. It should be simple in operation.
5. It should yield a product of uniform quality.

Coal cleaning equipment can be divided into two general classes, that using wet methods and that using dry methods of separation. For this discussion the wet methods will be sub-divided into the following processes: Chance Sand Floatation, Rheo-Laveur, jigs, and wet tabling and the second class will be discussed as air tabling.

Chance Sand Flotation Process

The Chance Sand Flotation Process was invented by T. M. Chance in the fall of 1915 and is merely a commercial application of the float and sink method of separation that has been used in testing laboratories for years. The process is based upon obtaining and maintaining a mixture of sand and water of such a specific gravity that the coal will float and the foreign impurities having a higher specific gravity than the coal, will sink. Any desired specific gravity between 1.2 and 1.8 can be obtained and maintained by mixing and agitating ordinary sands in water in different proportions.

The Chance Coal Cleaner consists of a conical separating tank designed to hold the mixture of sand and water; de-sanding shakers for removing the sand and water from the coal and refuse; a reservoir for collecting the sand and water coming from the de-sanding equipment; and a pumping system for returning the sand and water to the conical separating tank.

Chance Coal Cleaner Installations

In most installations of this type at least two cones are employed, one receiving the coal between 1 inch and 4½ inches and size and the other taking the coal between one-sixteenth and one inch in size. By the use of two or more cones a better separation between the coal and the slate is obtained. From the cones the cleaned coal passes to the de-sanding equipment where practically all the sand and water are removed and thence to the screens for a final sizing before shipment. The refuse is discharged at the bottom of the cones into a water sealed conveyor from which it is discharged onto the shakers and from there is deposited into some kind of dumping apparatus.

Practically all of the Chance Coal Cleaner Installations are in the anthracite regions. Bituminous operators have not as yet, generally accepted this process because of the difficulty of separating the sand from the fine coal. A much greater amount of fines is produced in the bituminous coal operations than in the anthracite. The cost of labor being the most important item. The cost of sand amounts to approximately $0.0063 per ton of coal shipped.

Rheo-Laveur Process

The Rheo-Laveur process is a modern adaptation of the old trough washer in which mixed feed particles are sorted by an open flowing stream of water. As in the Chance process, the separation depends primarily upon the differences in specific gravity between coal and the foreign impurities.

Rheo-Laveur plants are of two types, one having a sealed discharge for coarse coal and one having a free discharge for fine coal. The plant consists of a series of inclined launders into which raw coal and water are fed. A classification takes place in these launders forming a slow moving bed of refuse on the bottom, a faster moving layer of bone above, and coal on top moving quite rapidly. The slate and bone are removed from the launders through Rheo boxes, and only clean coal passes from the launders over the sizing screens on its way to the railroad cars.

(Continued on Page 20)

SHOVEL LOADING

COAL MINING

(Continued from Page 7)

JIGS

Jigs were the first means of coal cleaning of which there is any record having been used in the early part of the nineteenth century. The jig is an apparatus for classifying materials according to their specific gravities by means of a pulsating current of water. There are many different types of jigs but for this discussion only the Simon Carves Washer Box Unit manufactured by the Link Belt Co. of Chicago, will be considered.

The Simon Carves Washer Box is very similar to the old type jig which consisted of a two compartment box having a V-shaped bottom. In the old type a plunger in one compartment gave the water a pulsating motion resulting in a classification on a screen in the other compartment. The chief objection to this type of jig was the suction produced by the upstroke of the plunger, partially destroying the separation on the screen. The Link Belt Co. in their Simon Carves Washer Box, use compressed air in place of the plunger and by admitting water on the air side of the box to take the place of the air exhausted, practically eliminate all suction.

A single Washer Box 20 feet by 12 feet will handle up to 150 tons per hour of a feed ranging in size from 0 to 5 inches. After washing, the coal is dewatered to a moisture content of about 9 per cent.

WET TABLING

Table concentration is especially adapted to the cleaning of fine coal. The Butchart, Wilfley, and Deister-Overstrom concentrating tables, which have long been used in metallurgical plants, are in general use in coal washing plants. All of these tables are somewhat similar in construction. A peculiar reciprocating motion is imparted to the table by means of a cam action. This motion causes the coal to flow across the table and a separation is affected according to specific gravities, by this motion, the flow of water across the table, and the riffles on the surface of the table.

The big advantage of wet concentrating tables is the fact that the operator can observe and control the action of the table at all times. Concentrating tables consume little power and have a low initial cost, and as a result are quite extensively used in coal washing plants.

PNEUMATIC TABLING

Pneumatic tables employ the same principles as the wet concentrating tables, except that the water in the wet table is replaced by air in the Pneumatic table. The Arms Air Concentrator is typical of this type of table. The deck of the Arms table is made up of punched plates and screen cloth dressings through which air, as the separating medium, is applied to the coal. Riffles are mounted on metallic screen cloth and serve the same function as on the wet tables. The greatest advantage claimed for the pneumatic tables is the fact that no additional moisture is added to the coal in the process of cleaning, and thus the dewatering problem and the trouble with freezing in transit in winter are avoided.

The tendency toward mechanization and coal cleaning is having a very noticeable effect upon the coal industry. It is reducing the number of men underground per ton of coal mined. It is resulting in the employment of a greater percentage of skilled labor, and finally it is producing a great need for more technically trained men to superintend the operation of the mechanical equipment.